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USDA Forest Service Research Paper RM-95

October 1972

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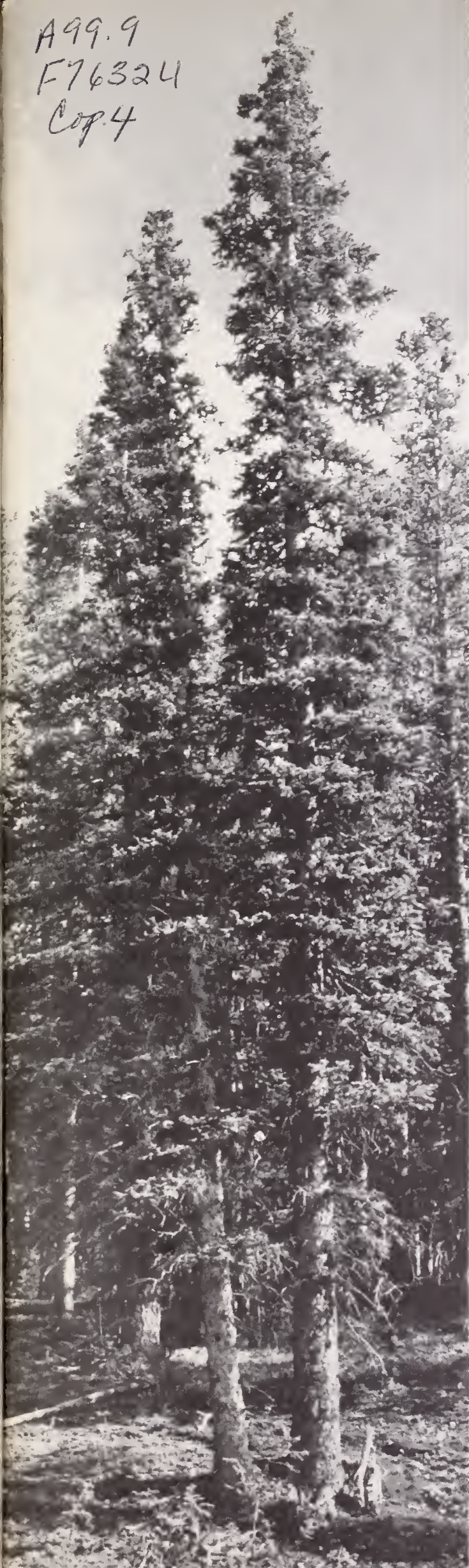
U.S. DEPT. OF AGRICULTURE

JOHN C. HARRIS

# Volume Tables and Point-Sampling Factors For Engelmann Spruce in Colorado and Wyoming

By  
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### ABSTRACT

Volumes are in total cubic feet and cubic feet to a 4.0-inch top, board feet Scribner Rule to 6-inch and 8-inch tops, and board feet International  $\frac{1}{4}$ -inch Rule to 6-inch and 8-inch tops. Tree heights are in feet and numbers of logs. Volume equations are of the form  $V = a + bD^2 H$ .

**Keywords:** Tree volume tables, tree volume estimates, stand volume estimates, *Picea engelmannii*.

**Volume Tables and Point-Sampling Factors for Engelmann Spruce  
in Colorado and Wyoming**

by

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# Contents

	Page
Definitions and Standards . . . . .	1
Explanation of Tables . . . . .	2
Volume Tables . . . . .	2
Point-Sampling Factors . . . . .	2
Literature Cited . . . . .	3
List of Tables	
1. Gross volumes of entire stem in cubic feet . . . . .	5
2. Gross merchantable volumes in cubic feet to a 4.0-inch top, total height . . . . .	6
3. Gross merchantable volumes in cubic feet per square foot of basal area . . . . .	7
4. Gross volumes in board feet Scribner Rule, 6-inch top, total height . . . . .	8
5. Gross volumes in board feet Scribner Rule, per square foot of basal area, total height . . . . .	9
6. Gross volumes in board feet Scribner Rule, 6-inch top, height in logs . . . . .	10
7. Gross volumes in board feet Scribner Rule per square foot of basal area, height in logs . . . . .	11
8. Gross volumes in board feet Scribner Rule, 8-inch top, total height . . . . .	12
9. Gross volumes in board feet Scribner Rule per square foot of basal area, total height . . . . .	13
10. Gross volumes in board feet Scribner Rule, 8-inch top, height in logs . . . . .	14
11. Gross volumes in board feet Scribner Rule per square foot of basal area, height in logs . . . . .	15
12. Gross volumes in board feet International 1/4-inch Rule, 6-inch top, total height . . . . .	16
13. Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, total height . . . . .	17
14. Gross volumes in board feet International 1/4-inch Rule, 6-inch top, height in logs . . . . .	18
15. Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, height in logs . . . . .	19
16. Gross volumes in board feet International 1/4-inch Rule, 8-inch top, total height . . . . .	20
17. Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, total height . . . . .	21
18. Gross volumes in board feet International 1/4-inch Rule, 8-inch top, height in logs . . . . .	22
19. Gross volumes in board feet International 1/4-inch Rule, height in logs . . . . .	23

# Volume Tables and Point-Sampling Factors for Engelmann Spruce in Colorado and Wyoming

Clifford A. Myers and Carleton B. Edminster

Nineteen tables presented here give values needed to determine the volumes of Engelmann spruce (*Picea engelmannii* Parry) trees in Colorado and southern Wyoming. They provide the following:

1. Gross volumes in total and merchantable cubic feet.
2. Gross volumes in board feet, Scribner and International  $\frac{1}{4}$ -inch log rules.
3. Point-sampling factors for merchantable cubic feet and board feet.

Volume on an area may be determined from: (1) measurements of tree diameters and heights, (2) measurements of diameters and of sufficient heights to convert the appropriate volume tables to local volume tables (Chapman and Meyer 1949), or (3) tree counts obtained by point-sampling.

Sample trees were measured by personnel of the Colorado State Forest Service and of the USDA Forest Service on the following eight National Forests: Arapaho, Grand Mesa-Uncompahgre, Gunnison, Medicine Bow, Rio Grande, Routt, San Juan, and White River.

## Definitions and Standards

Variables used in the tables, and standards followed in field measurement and computations, are as follows:

**Diameter breast high (d.b.h.).** — Measured to 0.1 inch outside bark 4.5 feet above ground level at the uphill side of the tree. Full-inch diameter classes, with class midpoints at the half-inch marks, were used in the tables (12.5, 13.5, and so forth).

**Scaling diameter of logs.** — Average diameter inside bark to 0.1 inch, measured at the upper (small) end of logs or half-logs. Saw-log diameter classes followed conventional scaling practice, with class midpoints at whole inches (12.0, 13.0, and so forth).

**Minimum top diameters for board-foot volumes.** — Two minimum top diameters inside bark, 6 and 8 inches. Actual utilization practices indicate that both limits are used for Engelmann spruce, and that the limit does not vary with tree diameter. Logs with a scaling diameter less than 5.6 inches for the 6-inch top and 7.6 inches for the 8-inch top usually were not included in saw-log volume. A few logs with smaller scaling diameters were included to satisfy requirements of the 4-foot rule, described below. This also conforms to local practice.

**Total height.** — Measured to the nearest foot from ground level at the tree base upward to the tip. Forked, stag-topped, or other deformed trees were not included in the sample. Midpoints of the total height classes used in the tables were multiples of 10.0 feet.

**Height in logs.** — Measured from the top of a stump 1.0 foot high upward to the limit of saw-log utilization. Each tree was divided into as many 16.5-foot-long logs as possible. An additional half-log, if present, was taken from the uppermost part of the merchantable length. Portions of the bole above the height of minimum top saw-log diameter were included in the uppermost saw-log if the standard length of the log or half-log ended within 4.0 feet above this height. This "4-foot rule" was used to avoid biased negative error in volume (Chapman and Meyer 1949).



## Explanation of Tables

General definitions and standards given above apply to all tables. Explanation of each type of table and suggestions for use are presented here.

### Volume Tables

Headings and footnotes with each volume table (table 1 and even-numbered tables) give the volume unit, type of height measurement, utilization standards, and volume equations used in its compilation. Ten-foot or half-log height classes and full-inch diameter classes were used in all tables.

The volume tables were derived from linear regressions in  $V$  and  $D^2H$ , of the form:

$$V = a + b D^2H$$

where:

$V$  = gross volume in the appropriate unit,

$D$  = diameter breast high outside bark,

$H$  = total height in feet or in standard logs and half-logs, and

$a, b$  = regression constants.

Two equations were used to derive each table except for table 8. Usually, the relationship between  $V$  and  $D^2H$  could not be expressed by a single linear regression over the full range of the basic data.

The number of logs in a tree shown in the tables is not necessarily the number that will actually be cut from it. Instead, it is the number of logs between the 1.0-foot stump and the height where minimum top diameter is reached. Volume of nonmerchantable logs below the height of minimum top diameter should be deducted from tree volume by: (1) estimation of scaling diameters and deduction of appropriate log volumes, (2) use of taper tables to determine scaling diameters and deduction of log volumes, or (3) reduction of total volume by the percentage of volume contained in the nonmerchantable log. Volume must not be reduced by tallying fewer logs in the tree.

### Point-Sampling Factors

Tables of point-sampling factors (odd-numbered tables from 3 to 19, inclusive) give the factors for each of numerous combinations of tree diameter and height. Tabulated volumes per square foot of basal area were obtained from the equations in the table footnotes. These equations resulted from the division of each term of the corresponding tree volume equation by  $0.005454D^2$ , a formula for basal area ( $B$ ).

Point-sample cruising for volume can be done in several ways: (1) measure the diameter and height of each tree counted through the prism or relascope, (2) measure the height of each counted tree and estimate its diameter, or (3) measure the heights of the counted trees and make no record of the diameters. The procedure selected will depend on the accuracy desired (relative accuracy usually in the order listed above) and the time and personnel available for the job.

If the diameter and height of each counted tree are measured, a volume conversion factor is selected for each combination of diameter and height. Factors are read from the appropriate factor table (odd-numbered tables from 3 to 19, inclusive) or computed from equations in the table footnotes. Volume per acre is computed as follows:

1. Multiply the number of counted trees in each diameter-height class by the point-sampling factor for the class.
2. Total the products of step one.
3. Multiply this total by the basal area factor of the prism or other angle gage used.
4. Divide the product of step three by the number of points sampled on the tract.

Time can often be saved if the heights of the counted trees are measured, while diameters are estimated and tallied by broad diameter classes. Inspection of the factor tables shows that volumes per square foot of basal area often do not differ greatly among trees of a single height class. For example, the merchantable cubic volumes of trees 70 feet tall vary from 26.2 to 29.4 cubic feet per square foot as diameter increases from 5 to 23 inches (table 3). Board feet per square foot of basal area changes little with diameter when tree heights are measured in logs (tables 7, 11, 15, 19). Therefore, the increased time spent measuring diameters may not increase accuracy materially.

It is recommended that diameters not be recorded at all when the distribution of diameters and heights on the area inventoried indicates there is little change in volume per square foot within a height class. Point-sampling factors based on height only can be computed from the factor tables given here.

The factor for each height class can be computed using almost the same procedure used to derive a local volume table from a standard table (Chapman and Meyer 1949). Diameters are plotted over heights, since height will be retained as the measured variable.

The techniques of point sampling have been adequately described in numerous publications (Bonnett 1959, Grosenbaugh 1952, 1955, 1958).



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Table 1.--Gross volumes of entire stem in cubic feet, Engelmann spruce in Colorado and Wyoming

Cubic feet inside bark															Total height above ground																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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Block indicates extent of basic data.  
 Derived from:  $V = 0.00239 D^2H + 0.06439$ , for  $D^2H$  to 22,500  
 $V = 0.00193 D^2H + 10.41663$ , for  $D^2H$  larger than 22,500  
 Standard errors of estimate:  $\pm 13.24$  percent;  $\pm 9.29$  percent  
 Diameter classes full-inch: e.g. 20-inch class includes 20.0 to 20.9



Table 2.--Gross merchantable volumes in cubic feet to a 4.0-inch top, Engelmann spruce in Colorado and Wyoming

Cubic feet inside bark										Top diameter 4.0 inches inside bark															
Merchantable stem excluding stump and top										Stump height 1.0 foot															
Diameter	Total height in feet										Basis:														
breast height											Trees														
outside bark																									
(Inches)	30	40	50	60	70	80	90	100	110	120	130														
----- Volume in cubic feet -----																									
5	1.28	1.98	2.68	3.38								26													
6	2.11	3.09	4.07	5.05	6.03							24													
7	3.08	4.39	5.69	7.00	8.30	9.61						19													
8	4.20	5.87	7.55	9.23	10.9	12.6						28													
9	5.45	7.55	9.64	11.7	13.8	15.9						22													
10	6.84	9.40	12.0	14.5	17.1	19.6	22.2					21													
11		11.4	14.5	17.6	20.6	23.7	26.8	29.9				40													
12			17.3	20.9	24.5	28.2	31.8	35.4				42													
13			20.3	24.5	28.8	33.0	37.2	41.5				11													
14				28.4	33.3	38.2	43.1	47.9	52.8			19													
15				32.6	38.2	43.8	49.3	54.9	60.5			21													
16				37.1	43.4	49.7	56.0	62.3	67.6			17													
17				41.8	48.9	56.0	63.1	68.9	74.4	80.0		11													
18					54.8	62.7	69.2	75.4	81.6	87.9		13													
19					60.9	68.5	75.4	82.3	89.2	96.2		11													
20					66.7	74.3	82.0	89.6	97.2	105	113	13													
21					72.0	80.4	88.8	97.2	106	114	122	10													
22					77.6	86.8	96.0	105	114	124	133	5													
23					83.5	93.5	104	114	124	134	144	7													
24						101	111	122	133	144	155	9													
25						108	120	131	143	155	167	6													
26						115	128	141	154	166	179	4													
27						123	137	151	165	178	192	7													
28							146	161	176	191	205	4													
29							156	171	187	203	219	4													
30							165	182	199	216	233	3													
31							176	194	212	230	248	1													
32								205	225	244	263	2													
33									238	258	279	0													
34										273	295	1													
35										288	311	0													
36										304	328	1													
Basis:																									
No. trees	14	34	40	57	69	84	101	118	135	152	169	186	203	220	237	254	271	288	305	322	339	356	373	390	407

Block indicates extent of basic data.  
 Derived from:  $V = 0.00232 D^2 H - 0.83010$ , for  $D^2 H$  to 27,900  
 $V = 0.00182 D^2 H + 13.11320$ , for  $D^2 H$  larger than 27,900  
 Standard errors of estimate:  $\pm 12.93$  percent;  $\pm 8.50$  percent  
 Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 3.--Gross merchantable volumes in cubic feet per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Cubic feet inside bark		Total height in feet										Top diameter 4.0 inches inside bark	
Merchantable stem excluding stump and top		Stump height 1.0 foot											
Diameter	:	30	40	50	60	70	80	90	100	110	120	130	
breast height	:												
outside bark	:												
(Inches)	:												
5		7.7	12.0	16.2	20.5								
6		9.2	13.4	17.7	21.9	26.2							
7		10.1	14.3	18.6	22.8	27.1	31.3						
8		10.7	14.9	19.2	23.4	27.7	31.9						
9		11.1	15.3	19.6	23.8	28.1	32.3						
10		11.4	15.6	19.9	24.1	28.4	32.7	36.9					
11			15.9		24.4	28.6	32.9	37.1	41.4				
12				20.3	24.5	28.8	33.1	37.3	41.6				
13				20.4	24.7	28.9	33.2	37.5	41.7				
14					24.8	29.1	33.3	37.6	41.8	46.1			
15					24.9	29.1	33.4	37.7	41.9	46.2			
16					25.0	29.2	33.5	37.7	42.0	45.5			
17					25.0	29.3	33.5	37.8	41.2	44.6	47.9		
18						29.3	33.6	37.1	40.4	43.7	47.1		
19						29.4	33.0	36.4	39.7	43.0	46.4		
20						29.1	32.4	35.8	39.1	42.4	45.8	49.1	
21						28.6	31.9	35.2	38.6	41.9	45.2	48.6	
22						28.1	31.4	34.8	38.1	41.5	44.8	48.1	
23						27.7	31.0	34.4	37.7	41.1	44.4	47.7	
24							30.7	34.0	37.4	40.7	44.0	47.4	
25							30.4	33.7	37.1	40.4	43.7	47.1	
26							30.1	33.5	36.8	40.1	43.5	46.8	
27							29.9	33.2	36.5	39.9	43.2	46.6	
28								33.0	36.3	39.7	43.0	46.3	
29								32.8	36.1	39.5	42.8	46.1	
30								32.6	36.0	39.3	42.6	46.0	
31								32.5	35.8	39.1	42.5	45.8	
32									35.6	39.0	42.3	45.7	
33										38.8	42.2	45.5	
34											42.1	45.4	
35											42.0	45.3	
36											41.8	45.2	

Derived from:  $V/B = 0.4254 H - 152.2002/D^2$ , above dotted line

$V/B = 0.3337 H + 2404.3271/D^2$ , below dotted line

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 4.--Gross volumes in board feet Scribner Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top		Total height in feet										Top diameter 6 inches inside bark Stump height 1.0 foot	
Diameter		40	50	60	70	80	90	100	110	120	130		
breast height outside bark (Inches)													Basis: Trees
7	10	16	22	28	34								19
8	17	24	32	40	48								28
9	24	34	44	54	64								22
10	33	45	57	70	82	94							22
11	43	57	72	86	101	115	131						40
12		71	88	105	122	141	160						42
13		85	105	125	147	169	191						11
14		100	124	149	174	200	225	250					19
15			145	174	203	232	261	290					21
16			168	201	234	267	299	332					17
17			193	230	267	303	340	377	414				11
18				260	301	342	383	425	466				13
19				292	338	383	429	475	521				11
20				326	376	427	477	528	578	629			13
21				361	417	472	528	583	639	694			10
22				398	459	520	581	641	702	763			5
23				437	503	570	636	702	769	835			7
24					549	621	694	766	838	910			9
25					597	676	754	832	910	988			6
26					647	732	816	901	985	1069			4
27					699	790	881	972	1063	1154			7
28						851	948	1046	1144	1241			4
29						914	1018	1123	1227	1332			4
30						978	1090	1202	1314	1426			3
31						1046	1165	1284	1403	1523			1
32							1242	1369	1496	1623			2
33								1456	1591	1726			0
34									1689	1832			1
35									1790	1941			0
36									1894	2054			1
Basis:													
No. trees	13	26	54	69	63	48	48	25	4	3			353

Block indicates extent of basic data.

Derived from:  $V = 0.01097 D^2 H - 15.14466$ , for  $D^2 H$  to 12,200

$V = 0.01202 D^2 H - 27.91343$ , for  $D^2 H$  larger than 12,200

Standard errors of estimate:  $\pm 15.91$  percent;  $\pm 13.63$  percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9



Table 5.--Gross volumes in board feet Scribner Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark										Top diameter 6 inches inside bark					
Merchantable stem excluding stump and top										Stump height 1.0 foot					
Diameter	:	Total height in feet													
breast height	:	40	50	60	70	80	90	100	110	120	130				
outside bark	:														
(Inches)	:														
----- Board feet -----															
7		31	51	71	91	111									
8		42	62	82	102	122									
9		50	70	90	110	130									
10		55	75	95	116	136	156								
11		59	80	100	120	140	160	182							
12			83	103	123	144	166	188							
13			85	105	126	148	170	192							
14			87	108	130	152	174	196	218						
15				111	133	155	177	199	221						
16				113	135	158	180	202	224						
17				116	138	160	182	204	226	248					
18					139	161	183	205	227	250					
19					141	163	185	207	229	251					
20					142	164	186	208	230	252	274				
21					143	165	187	209	231	253	275				
22					144	166	188	210	232	254	276				
23					145	167	189	211	233	255	277				
24						168	190	212	234	256	278				
25						168	190	213	235	257	279				
26						169	191	213	235	257	279				
27						170	192	214	236	258	280				
28							192	214	236	258	280				
29							192	215	237	259	281				
30							193	215	237	259	281				
31							193	215	237	259	281				
32								216	238	260	282				
33									238	260	282				
34										260	282				
35										260	282				
36										261	283				

Derived from:  $V/B = 2.0114 H - 2776.7987/D^2$ , above dotted line

$V/B = 2.2039 H - 5117.9740/D^2$ , below dotted line

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 6.--Gross volumes in board feet Scribner Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top		Number of 16-foot logs to 6-inch top										Top diameter 6 inches inside bark Stump height 1.0 foot			
Diameter breast height outside bark	(Inches)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	Basis:
															Trees
----- Volume in board feet -----															
7		19	25	32											19
8		22	31	39	48										28
9		27	37	48	58	69									22
10		31	44	57	70	83	96								22
11		36	52	68	83	99	114	130							40
12			61	79	97	116	134	152	171						42
13				91	113	134	155	177	198						11
14					129	154	178	203	228	253					19
15						175	203	231	260	288					21
16					147	175	230	262	294	326	358				17
17					165	197	258	294	330	366	402				11
18					185	221	287	327	368	408	448	488			13
19						247	318	363	408	453	497	542			11
20						302	386	440	495	549	603	657	647		13
21							422	482	541	601	659	718	710		10
22													776		5
23							460	525	590	654	718	781	845		7
24							500	570	640	709	779	848	917		9
25							541	617	692	767	842	917	992		6
26							584	665	746	827	908	989	1070		4
27							627	715	802	889	977	1064	1151		7
28								767	860	954	1048	1142	1236		4
29									921	1021	1122	1222	1323		4
30									983	1090	1198	1305	1413	1520	3
31									1047	1162	1277	1391	1506	1620	1
32										1236	1358	1480	1602	1724	2
33											1442	1571	1701	1831	0
34												1666	1803	1941	1
35												1763	1908	2054	0
36												1862	2016	2170	1
Basis:															
No. trees		31	34	29	42	39	50	37	35	28	21	4	2	1	353

Block indicates extent of basic data.

Derived from:  $V = 0.23522 D^2_L + 5.37508$ , for  $D^2_L$  to 2530  
 $V = 0.23097 D^2_L + 16.11994$ , for  $D^2_L$  larger than 2530

Standard errors of estimate:  $\pm 15.05$  percent;  $\pm 11.92$  percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 7.--Gross volumes in board feet Scribner Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top													Top diameter 6 inches inside bark Stump height 1.0 foot			
Diameter breast height outside bark (Inches)	:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0		
----- Board feet -----																
7	:	61	82	104												
8	:	57	78	100	121											
9	:	54	76	97	119	140										
10	:	52	74	95	117	138	160									
11	:	51	72	94	115	137	158	180								
12	:		71	93	114	136	157	179	200							
13	:			92	113	135	156	178	199							
14	:				113	134	156	177	199	220						
15	:				112	133	155	177	198	220						
16	:				111	133	155	176	198	219	241					
17	:				111	133	154	176	197	219	240					
18	:					132	154	175	197	219	240	262				
19	:					132	154	175	197	218	240	261				
20	:					132	153	175	196	218	240	261				
21	:						153	175	196	218	239	260	282			
22	:						153	174	196	218	239	260	281			
23	:						153	174	196	217	238	259	281			
24	:						153	174	195	217	238	259	280			
25	:						152	174	195	216	237	259	280			
26	:						152	174	195	216	237	258	279			
27	:						152	173	194	216	237	258	279			
28	:							173	194	215	237	258	279			
29	:								194	215	236	257	279			
30	:								194	215	236	257	278	300		
31	:								194	215	236	257	278	299		
32	:									215	236	257	278	299		
33	:										236	257	278	299		
34	:											257	278	299		
35	:												278	299		
36	:													277		

Derived from:  $V/B = 43.1280 L + 985.5299/D^2$ , above dotted line.  
 $V/B = 42.3487 L + 2955.6179/D^2$ , below dotted line.

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9



Table 8.--Gross volumes in board feet Scribner Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top		Total height in feet										Top diameter 8 inches inside bark Stump height 1.0 foot		Basis: Trees
Diameter breast height outside bark (Inches)	:	40	50	60	70	80	90	100	110	120	130	:	:	:
----- Volume in board feet -----														
10	:	15	28	41	55	68	82							23
11	:	25	41	57	74	90	106	122						41
12	:		56	75	94	113	132	151						42
13	:		72	94	116	138	160	182						12
14	:		89	114	140	165	191	216	242					24
15	:			136	165	195	224	253	282					24
16	:			160	193	226	259	292	325					22
17	:			184	221	259	296	333	370	408				15
18	:				252	294	335	377	418	460				16
19	:				284	331	377	423	469	515				12
20	:				318	370	421	472	523	574	625			13
21	:				354	410	467	523	579	635	691			12
22	:				392	453	515	576	638	699	761			6
23	:				431	498	565	632	699	766	833			7
24	:					544	617	690	763	836	909			9
25	:					593	672	751	830	909	988			6
26	:					644	729	814	900	985	1070			5
27	:					696	788	880	972	1064	1156			7
28	:						849	948	1047	1145	1244			4
29	:						913	1018	1124	1230	1336			4
30	:						978	1091	1204	1317	1430			3
31	:						1046	1167	1287	1408	1528			1
32	:							1244	1373	1501	1629			2
33	:								1461	1597	1734			0
34	:									1696	1841			1
35	:									1798	1952			0
36	:									1903	2065			1
-----														
Basis:	:													
No. trees	:	1	7	31	68	72	53	48	25	4	3			312

Block indicates extent of basic data.

Derived from:  $V = 0.01215 D^2 H - 38.96822$

Standard error of estimate:  $\pm 16.40$  percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 9.--Gross volumes in board feet Scribner Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top					Top diameter 8 inches inside bark Stump height 1.0 foot						
Diameter breast height outside bark (Inches)	:	40	50	60	70	80	90	100	110	120	130
----- Board feet -----											
10	:	24	47	69	91	113	136				
11	:	35	57	80	102	124	146	169			
12	:		66	88	110	132	155	177			
13	:		72	94	117	139	161	184			
14	:		77	100	122	144	167	189	211		
15	:			104	126	148	171	193	215		
16	:			107	130	152	174	197	219		
17	:			110	133	155	177	199	222	244	
18	:				135	157	180	202	224	246	
19	:				137	159	182	204	226	249	
20	:				139	161	183	206	228	250	273
21	:				140	163	185	207	230	252	274
22	:				142	164	186	209	231	253	275
23	:				143	165	188	210	232	254	277
24	:					166	189	211	233	255	278
25	:					167	190	212	234	256	279
26	:					168	190	213	235	257	279
27	:					169	191	213	236	258	280
28	:						192	214	236	259	281
29	:						192	215	237	259	281
30	:						193	215	237	260	282
31	:						193	216	238	260	282
32	:							216	238	261	283
33	:								239	261	283
34	:									261	284
35	:									262	284
36	:									262	284

Derived from:  $V/B = 2.2277 H - 7144.8882/D^2$

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 10.--Gross volumes in board feet Scribner Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark										Top diameter 8 inches inside bark									
Merchantable stem excluding stump and top										Stump height 1.0 foot									
Diameter breast height outside bark (Inches)	:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	Basis: Trees				
----- Volume in board feet -----																			
10	:	37	51	65	79										23				
11	:	42	59	76	93	110									41				
12	:	48	68	89	109	129	149								42				
13	:		79	102	125	149	172	196							12				
14	:		89	116	143	170	198	225	252						24				
15	:			132	163	194	225	255	286						24				
16	:			148	183	218	253	288	322	355					22				
17	:			166	205	245	284	322	359	396					15				
18	:				228	272	316	357	398	439	480				16				
19	:				253	302	348	393	439	484	530				12				
20	:					331	381	432	482	532	583	633			13				
21	:					361	416	472	527	583	638	694			12				
22	:					393	453	514	575	636	696	757			6				
23	:					426	492	558	625	691	757	823			7				
24	:						532	604	676	748	820	892			9				
25	:						574	652	730	808	886	964			6				
26	:														5				
27	:						618	702	786	871	955	1039			7				
28	:						663	754	845	935	1026	1117			4				
29	:							808	905	1003	1100	1197			4				
30	:							863	968	1072	1177	1281	1385	1490					
31	:							921	1033	1144	1256	1367	1479	1590	3				
32	:								1099	1218	1337	1456	1575	1694	1				
33	:								1169	1295	1422	1549	1675	1802	2				
	:									1374	1509	1644	1778	1913	0				
34	:																		
35	:											1741	1884	2027	1				
36	:											1842	1993	2144	0				
	:											1946	2106	2265	1				
-----																			
Basis:																			
No. Trees	:	15	27	41	42	45	43	33	29	23	8	4	2	0	312				

Block indicates extent of basic data.  
 Derived from:  $V = 0.25726 D^2_L + 8.19211$ , for  $D^2_L$  to 1160  
 $V = 0.23987 D^2_L + 28.40381$ , for  $D^2_L$  larger than 1160  
 Standard errors of estimate:  $\pm 12.43$  percent;  $\pm 10.79$  percent  
 Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9



Table 11.--Gross volumes in board feet Scribner Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top										Top diameter 8 inches inside bark Stump height 1.0 foot				
Diameter breast height outside bark (Inches)	:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
----- Board feet -----														
10	:	61	84	108	132									
11	:	59	82	106	129	153								
12	:	57	80	104	128	151	175							
13	:		79	103	126	150	173	197						
14	:		78	101	125	149	172	196	219					
15	:			101	124	148	171	195	219					
16	:			100	123	147	171	194	217	239				
17	:			99	123	146	170	193	215	237				
18	:				122	146	169	191	213	235	257			
19	:				122	145	168	190	212	234	256			
20	:					144	166	188	210	232	254	276		
21	:					143	165	187	209	231	253	275		
22	:					142	164	186	208	230	252	274		
23	:					141	163	185	207	229	251	273		
24	:						163	185	207	229	251	273		
25	:						162	184	206	228	250	272		
26	:						161	183	205	227	249	271		
27	:						161	183	205	227	249	271		
28	:							182	204	226	248	270		
29	:							182	204	226	248	270	292	314
30	:							182	204	226	247	269	291	313
31	:								203	225	247	269	291	313
32	:								203	225	247	269	291	313
33	:									225	247	269	291	313
34	:											268	290	312
35	:											268	290	312
36	:											268	290	312

Derived from:  $V/B = 47.1691 L + 1502.0370/D^2$ , above dotted line

$V/B = 43.9806 L + 5207.8860/D^2$ , below dotted line

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 12.--Gross volumes in board feet International 1/4-inch Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark										Top diameter 6 inches inside bark		
Merchantable stem excluding stump and top										Stump height 1.0 foot		
Diameter	Total height in feet									Basis:		
breast height										Trees		
outside bark												
(Inches)												
	Volume in board feet											
	-----									-----		
	40	50	60	70	80	90	100	110	120	130		

Table 13.--Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top										Top diameter 6 inches inside bark Stump height 1.0 foot			
Diameter breast height outside bark (Inches)	:	40	50	60	70	80	90	100	110	120	130		
----- Board feet -----													
7	:	19	44	70	95	121							
8	:	37	63	88	114	139							
9	:	50	75	101	126	152							
10	:	59	85	110	136	161	187						
11	:	67	92	118	143	169	194	220					
12	:		97	123	148	174	199	225					
13	:		102	127	153	178	204	229					
14	:		105	131	156	182	207	233	258				
15	:			133	159	184	210	235	261				
16	:			136	161	187	212	238	261				
17	:			138	163	189	214	237	259	282			
18	:				165	190	213	236	258	281			
19	:				166	189	212	235	257	280			
20	:				166	189	211	234	257	279	302		
21	:				165	188	211	233	256	278	301		
22	:				165	187	210	233	255	278	301		
23	:				164	187	209	232	255	277	300		
24	:					186	209	232	254	277	300		
25	:					186	209	231	254	277	299		
26	:					186	208	231	254	276	299		
27	:					185	208	231	253	276	298		
28	:						208	230	253	276	298		
29	:						207	230	253	275	298		
30	:						207	230	252	275	298		
31	:						207	230	252	275	298		
32	:							229	252	275	297		
33	:								252	275	297		
34	:									274	297		
35	:										274		
36	:										274		

Derived from:  $V/B = 2.5504 H - 4695.6766/D^2$ , above dotted line

$V/B = 2.2644 H + 3120.7902/D^2$ , below dotted line

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9



Table 14.--Gross volumes in board feet International 1/4-inch Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top		Number of 16-foot logs to 6-inch top											Top diameter 6 inches inside bark Stump height 1.0 foot	
Diameter breast height outside bark (Inches)		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
7	20	28	36											
8	24	34	45	55										19
9	29	42	55	68	80									28
10	35	51	66	82	97	113								22
11	41	60	79	97	116	135	153							22
12		70	92	114	136	158	180	203						40
13			107	133	158	184	210	236						42
14				152	182	212	242	271	301					11
15					208	242	275	309	343					19
16				174	235	273	312	350	388	420				21
17				196	264	307	350	392	428	464				17
18				220	294	342	390	430	471	511	551			11
19					326	380	426	471	515	560	605			13
20					360	414	463	513	563	612	662	712		11
21						449	503	558	612	667	721	776		13
22						485	545	604	664	724	784	844		10
23							588	653	719	784	849	914		5
24						523	633	704	775	846	917	988		7
25						563	681	757	834	911	988	1065		9
26						604	730	813	896	979	1062	1144		6
27						647								4
28						692	781	870	959	1049	1138	1227		7
29							834	930	1026	1121	1217	1313		4
30								991	1094	1197	1300	1402		4
31								1055	1165	1275	1385	1494	1604	3
32								1121	1238	1355	1472	1590	1707	1
33														
34									1314	1438	1563	1688	1813	2
35										1524	1657	1789	1922	0
36											1753	1894	2034	1
											1852	2001	2150	0
											1954	2112	2269	1
Basis: No. Trees		31	34	29	42	39	50	37	35	28	21	4	2	1
														353

Block indicates extent of basic data.

Derived from:  $V = 0.28272 D^2_L + 3.79359$ , for  $D^2_L$  to 1350

$V = 0.23616 D^2_L + 66.44465$ , for  $D^2_L$  larger than 1350

Standard errors of estimate:  $\pm 15.12$  percent;  $\pm 11.35$  percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 15.--Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top										Top diameter 6 inches inside bark Stump height 1.0 foot				
Diameter breast height outside bark (Inches)	:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
----- Board feet -----														
7	:	64	90	116										
8	:	61	87	113	139									
9	:	60	85	111	137	163								
10	:	58	84	110	136	162	188							
11	:	57	83	109	135	161	187	213						
12	:		82	108	134	160	186	212	238					
13	:			107	133	159	185	211	237					
14	:				133	159	185	211	237	262				
15	:				132	158	184	210	236	262				
16	:				132	158	184	210	236	261	283			
17	:				132	158	184	210	235	256	278			
18	:					158	183	209	230	252	274	295		
19	:					157	183	205	227	249	270	292		
20	:					157	181	202	224	245	267	289	310	
21	:						178	200	221	243	265	286	308	
22	:						176	197	219	241	262	284	306	
23	:						174	195	217	239	260	282	304	
24	:						172	193	215	237	258	280	302	
25	:						170	192	214	235	257	279	300	
26	:						169	191	212	234	255	277	299	
27	:						168	189	211	233	254	276	298	
28	:							188	210	232	253	275	296	
29	:								209	231	252	274	295	
30	:								208	230	251	273	295	316
31	:								207	229	250	272	294	315
32	:									228	250	271	293	315
33	:										249	271	292	314
34	:											270	292	313
35	:											269	291	313
36	:											269	291	312

Derived from:  $V/B = 51.8372 L + 695.5611/D^2$ , above dotted line

$V/B = 43.3003 L + 12182.7374/D^2$ , below dotted line

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 16.--Gross volumes in board feet International 1/4-inch Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark										Top diameter 8 inches inside bark			
Merchantable stem excluding stump and top										Stump height 1.0 foot			
Diameter	Total height in feet									Basis:			
breast height										Trees			
outside bark	40	50	60	70	80	90	100	110	120	130			
(Inches)	:	:	:	:	:	:	:	:	:	:	:		
----- Volume in board feet -----													
10	18	33	49	65	80	96							23
11	30	49	68	86	105	123	142						41
12		66	88	110	132	154	176						42
13		84	110	135	161	187	212						12
14		104	133	163	193	222	249	276					24
15			159	193	226	257	288	319					24
16			186	224	259	294	329	364					22
17			214	254	294	333	373	412	452				15
18				287	331	375	419	463	507				16
19				321	370	419	468	517	566				12
20				357	411	465	519	574	628	682			13
21				395	455	514	573	633	692	752			12
22				435	500	565	630	695	760	826			6
23				476	547	618	689	760	831	903			7
24					597	674	751	828	906	983			9
25					648	732	815	899	983	1067			6
26					702	792	882	973	1063	1154			5
27					757	855	952	1049	1147	1244			7
28						919	1024	1128	1233	1338			4
29						987	1099	1211	1323	1435			4
30							1176	1296	1415	1535			3
31						1056	1256	1383	1511	1639			1
32						1128	1338	1474	1610	1746			2
33							1567	1712	1856				0
34								1817	1970				1
35								1925	2087				0
36								2036	2208				1
-----													
Basis:													
No. Trees	1	7	31	68	72	53	48	25	4	3	312		

Block indicates extent of basic data.

Derived from:  $V = 0.01407 D^2H - 44.08214$ , for  $D^2H$  to 18,900

$V = 0.01287 D^2H - 21.43152$ , for  $D^2H$  larger than 18,900

Standard errors of estimate:  $\pm 17.12$  percent;  $\pm 15.95$  percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 17.--Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark		Total height in feet										Top diameter 8 inches inside bark	
Merchantable stem excluding stump and top												Stump height 1.0 foot	
Diameter breast height outside bark (Inches)	:	40	50	60	70	80	90	100	110	120	130		
10	:	30	56	81	107	133	159						
11	:	42	68	94	119	145	171	197					
12	:		77	103	129	155	180	206					
13	:		85	110	136	162	188	214					
14	:		91	116	142	168	194	217	241				
15	:			121	147	172	196	220	243				
16	:			125	151	174	198	222	245				
17	:			128	152	176	200	223	247	270			
18	:				154	177	201	224	248	272			
19	:				155	178	202	226	249	273			
20	:				156	179	203	227	250	274	297		
21	:				157	180	204	227	251	275	298		
22	:				157	181	205	228	252	275	299		
23	:				158	182	205	229	252	276	300		
24	:					182	206	229	253	277	300		
25	:					183	206	230	254	277	301		
26	:					183	207	230	254	278	301		
27	:					184	207	231	254	278	302		
28	:						208	231	255	278	302		
29	:						208	231	255	279	302		
30	:						208	232	255	279	303		
31	:						208	232	256	279	303		
32	:							232	256	279	303		
33	:								256	280	303		
34	:									280	303		
35	:									280	304		
36	:									280	304		

Derived from:  $V/B = 2.5798 H - 8082.5339/D^2$ , above dotted line

$V/B = 2.3597 H - 3929.5049/D^2$ , below dotted line

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9



Table 18.--Gross volumes in board feet International 1/4-inch Rule, Engelmann spruce in Colorado and Wyoming

Board feet inside bark Merchantable stem excluding stump and top		Number of 16-foot logs to 8-inch top										Top diameter 8 inches inside bark Stump height 1.0 foot			
Diameter breast height outside bark (Inches)	:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	Basis: Trees
----- Volume in board feet -----															
10	:	42	59	76	93										23
11	:	49	69	90	110	131									41
12	:	56	80	105	129	153	177								42
13	:		92	121	149	177	205	233							12
14	:		105	138	170	203	235	268	300						24
15	:			156	193	231	268	305	340						24
16	:			176	218	260	302	342	376	409					22
17	:			197	244	292	338	376	414	451					15
18	:				272	325	369	411	454	496	538				16
19	:				301	355	402	449	496	543	589				12
20	:				332	385	436	488	540	592	644	695			13
21	:					416	473	530	587	644	701	758			12
22	:					448	511	573	635	698	760	823			6
23	:					482	550	618	686	754	823	891			7
24	:						592	666	740	814	888	962			9
25	:						635	715	795	875	955	1036			6
26	:						680	766	853	939	1026	1112			5
27	:						726	819	913	1006	1099	1192			7
28	:							875	975	1075	1175	1275	1375	1475	4
29	:							932	1039	1146	1254	1361	1468	1575	4
30	:							991	1106	1220	1335	1450	1564	1679	3
31	:								1174	1297	1419	1541	1664	1786	1
32	:								1245	1376	1506	1636	1766	1896	2
33	:									1457	1595	1734	1872	2010	0
34	:												1981	2127	1
35	:												2093	2248	0
36	:												2208	2372	1
-----															
Basis:	:														
No. Trees	:	15	27	41	42	45	43	33	29	23	8	4	2	0	312

Block indicates extent of basic data.

Derived from:  $V = 0.30857 D^2_H + 8.14191$ , for  $D^2_L$  to 1060

$V = 0.24647 D^2_H + 73.92559$ , for  $D^2_L$  larger than 1060

Standard errors of estimate:  $\pm 12.51$  percent;  $\pm 10.50$  percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 19.--Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, Engelmann spruce in Colorado and Wyoming

Board feet inside bark														Top diameter 8 inches inside bark		
Merchantable stem excluding stump and top														Stump height 1.0 foot		
Diameter	:	Number of 16-foot logs to 8-inch top														
breast height	:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0		
outside bark	:															
(Inches)	:	----- Board feet -----														-----
10	:	70	98	127	155											
11	:	68	96	124	153	181										
12	:	66	94	123	151	179	208									
13	:		93	121	150	178	206	234								
14	:		92	120	149	177	205	233	262							
15	:			119	148	176	204	233	260							
16	:			119	147	175	204	231	253	276						
17	:			118	146	175	202	225	248	270						
18	:				146	174	198	220	243	266	288					
19	:				145	171	194	216	239	262	284					
20	:				145	168	190	213	236	258	281	303				
21	:					165	187	210	233	255	278	300				
22	:					162	185	208	230	253	275	298				
23	:					160	183	205	228	250	273	296				
24	:						181	203	226	249	271	294				
25	:						179	202	224	247	269	292				
26	:						177	200	223	245	268	290				
27	:						176	199	221	244	266	289				
28	:							197	220	243	265	288	310	333		
29	:							196	219	242	264	287	309	332		
30	:							195	218	241	263	286	308	331		
31	:								217	240	262	285	307	330		
32	:								216	239	261	284	307	329		
33	:									238	261	283	306	328		
34	:										261	283				
35	:											283	305	328		
36	:											282	304	327		
	:											281	304	327		

Derived from:  $V/B = 56.5768 L + 1492.8328/D^2$ , above dotted line $V/B = 45.1907 L + 13554.3803/D^2$ , below dotted line

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9



Myers, Clifford A., and Carleton B. Edminster.

1972. Volume tables and point-sampling factors for Engelmann spruce in Colorado and Wyoming. USDA Forest Serv. Res. Pap. RM-95, 23 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado 80521.

Volumes are in total cubic feet and cubic feet to a 4.0-inch top, board feet Scribner Rule to 6-inch and 8-inch tops, and board feet International  $\frac{1}{4}$ -inch Rule to 6-inch and 8-inch tops. Tree heights are in feet and numbers of logs. Volume equations are of the form  $V = a + bD^2 H$ .

**Keywords:** Tree volume tables, tree volume estimates, stand volume estimates, *Picea engelmannii*.

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